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RECOGNITION OF TRAFFIC SIGN FOR DRIVER ASSISTANCE SYSTEMS

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Abstract: **This paper deals with the automatic detection and recognition of traffic sign boards in Indian roads to alert the driver. A camera fitted in the car captures the video and sends the data to an in-vehicle computing device. We propose a four stage algorithm that detects the traffic signs using YCbCr colour space and shape based filtering. The detected traffic signs are tracked and recognized using interest point descriptors. The algorithm is robust and can detect signs even when traffic sign board is rotated. The traffic sign template database can be updated easily. The method is aimed at achieving high accuracy in recognizing traffic signs at real-time, with a low computational cost. Reduced computational complexity of the algorithm enables the implementation of the proposed method in embedded systems for driver assistance.**

Keywords: **Traffic Sign detection, Colour Segmentation, YCbCr Colour space, Interest Point Descriptors**

I. INTRODUCTION

Traffic sign detection is a consequential step in providing advanced driver assistance system inside the car, mapping data for GIS (geographical information systems) and also developing autonomous (self-driving) cars. At times, the warning signs on the sides of the road become difficult to notice and the driver may sometimes miss important warning notes. These warning notes may be speed breaker ahead or narrow bridge or even accident zone etc. This issue becomes critical at night time. Sometimes because of the traffic or the road condition, the driver may not be able to read the sign and if he tries to read it with a wide eye there may be a chance for the driver to lose concentration on the road. The project aims at developing a solution for this problem using image processing technique. By placing a camera in the car, it can pick up road signs and send it to a system that processes the image. The objective of this work is to process real-time video frames, detect traffic signs and match the detected signs to a database of traffic signs for successful recognition. The Main components of the proposed computer vision design flow are shown in figure 1. Section A presents the initial phase of the algorithm which extracts traffic signs based on primary colour used on traffic sign board. Section B shows the validation of traffic signs using shape based filtering. Section C shows the tracking of traffic signs and the recognition of traffic sign using interest point descriptors is discussed in Section D.

II. RELATED WORK

The automatic sign detection is has been an

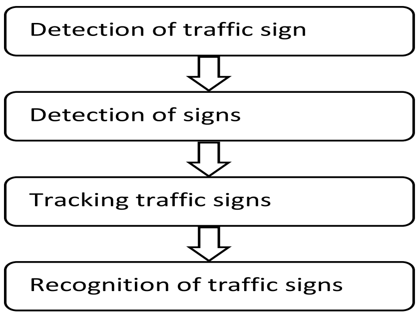

Figure 1.1 Design flow for traffic sign recognition

emerging field of research in recent years. Many car companies are integrating this system such as Ford Focus which can displays the certain number of detected traffic signs in the instrument panel [1]. This information will be helpful for the driver and it can improve the road safety. Also many researches are carried out for the automatic detection of traffic signs [2], [3], [4]. RGB colour space is used by various systems [5], it used for identification of traffic signs. Colour information can be a better feature for traffic sign analysis [4]. Other than colour another important characteristics used is shape based detection of traffic signs. Some techniques have used for shape based segmentation

such as template matching, radial base symmetry [8] and corner detection. A fast interest point detector can be used based on SURF (Speeded Up Robust Features) algorithm which was first introduced in 2006 by Bay et al. [7]. So for detection of traffic signs various methods have been developed.

III. Proposed Method

We proposed the system for the detection and recognition of Indian traffic signs and this method has three stages: Video capturing, detection and the recognition phase and it is shown in fig 3.1.The camera in the car take the videos of the road side traffic signs and the frames are sampled from the video which is taken by the camera. Each frame is subjected to colour space conversion. Colour extraction and shape parameter analysis is done for the detection of traffic sign location. We look for same patterns in consecutive frames and track the traffic signs. If it exists, then perform recognition using predefined templates. Alert the driver by playing the corresponding voice for recognized traffic signs.

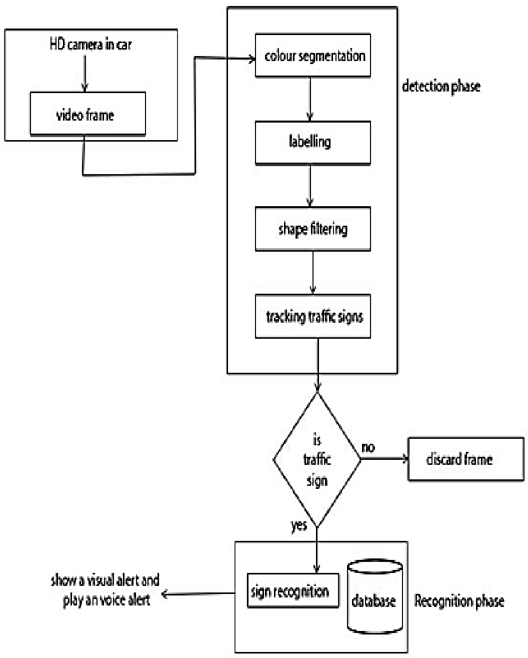

Figure 3.1: Colour extraction and shape parameter for the detection of traffic sign location.

A. *Detection of Traffic Sign Location*

Traffic signs have two major features: Shape (square, circle, triangle, hexagon etc.) and Color (red, yellow, orange, white, black, green). Detecting shapes in an urban environment is very challenging and unreliable due to visual clutter. On the other hand, traffic signs deliberately use raw/primary colors that stand out. Hence, color information can be a better feature for traffic sign analysis [5]. It is important to note that this work is primarily concerned with the day time detection of traffic signs. Night time would be different due to low light conditions and reflections.

1) *Colour Segmentation*

All the compulsory traffic signs are mainly in red colour. Hence by extracting the red colour from the frame, we can get the location of the traffic signs. For extraction and analysing the colour information, there are several methods available. RGB colour space is the default colour space of the image. But RGB colour space is not suitable for because it does not provide linear space for colour variation. So RGB image

Figure 3.2: Image captured during daylight

Figure 3.3: Cb Plane

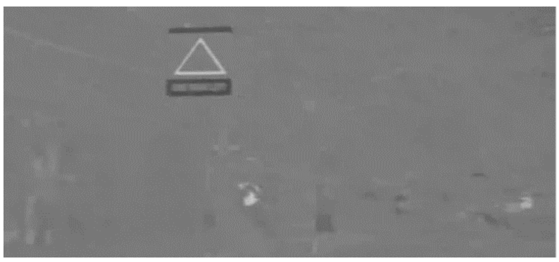

Figure: 3.4 Cr Plane

Figure 3.5: Cb Plane closing

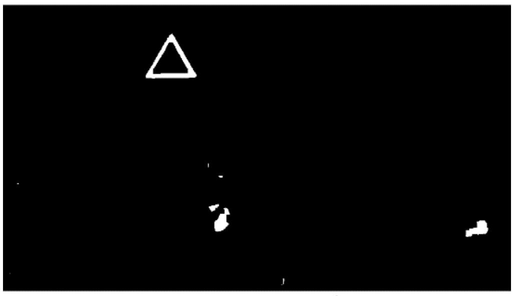

Figure 3.6: Cr Plane after closing

is converted into YCbCr colour space. YCbCr defines colour via one luminance value and two chrominance values i.e. Y carries luminance (brightness), Cb plane carries blue Chroma and Cr plane carries red Chroma. We are taking only the Cr plane to extract the red colour in the picture.

After the extracting red colour the output will be binary image. To close the open are we do a morphological operation. After closed area is bounded by box. The figure 3.2 represents the image which is taken in day time, figure 3.3 and figure 3.4 is Cb and Cr plane of the figure 1.1 respectively. Figure 3.5 and Figure 3.6 shows the Cb and Cr plane after morphological functions.

2) Labelling

After color extraction and morphological operations, multiple boundary boxes are detected. Next, these areas are separated from each other using a labeling operation. This step finds the shapes of the boundary boxes and labels them in order to get potential coordinates of traffic signs.

Detection of traffic sign locations is computationally very complex and require large memory accesses and pixel per pixel scanning. Typical image size used is 1280*720 = 921600 pixels.

B. Detection Of Traffic Signs

The second part of the algorithm handles the sorting and detection of actual traffic signs from the list of boundary boxes obtained. Initially, we trained a classifier using color and shape data, however results were not promising due to irregular traffic sign shapes encountered due to viewing angle, distortion and other effects. This can be done by shape based filtering.

1) Shape Based Filtering

In India, the alert signs are represented by triangle and compulsory signs are represented by circle. So by taking the two circles and triangle shape, we can filter or validate the detected boxes. Shape based filtering is based on template matching. The output of labelling is cropped picture of detection red colours. First it is resized to 150 x 150 pixels and it is matched with the templates by normalized cross correlation technique. It matched even in the angle of up to +/- 15 degrees. It checks for the similarity if similarity is more than certain threshold value then it is valid signs. The output for the detected sign for the input image is shown in Figure 3.7 with classification as warning sign

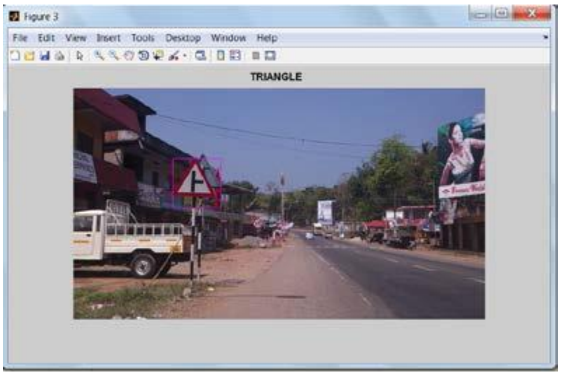

Figure 3.7: Detected traffic signs as warning signs

C. Tracking of Traffic Signs

In tracking phase, we double check the sign by finding whether the same sign exists in the consecutive frames. In this phase the bounding box matching is done to know if sign exists in more than one frame and hence it is a valid target.

D. Recognition of Traffic Signs

The last stage of the algorithm is the recognition of the traffic signs. The key principle is to match the detected signs to a database (library) of traffic sign templates. Several techniques can be used for this purpose. Using norm squared difference is straightforward, however it fails to work when the traffic signs are distorted, marked or seen from an angle. Neural networks can improve the recognition performance. However, training neural networks for hundreds of traffic sign templates is a time consuming task. As an alternative, a fast

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interest point detector can be used based on SURF (Speeded Up Robust Features) algorithm which was first introduced in 2006 by Bay et al. [10]. SURF can be used as a detector (finding interesting points at distinctive locations in the image such as blobs, corners etc.) and a descriptor (a feature vector representing the neighbourhood of interest points). More importantly, descriptor vectors can be matched between different images to find any correspondence among images. Specifically, we use the Upright-SURF (USURF) [9] which can maintain robustness for image rotations of up to +/− 15 degree and can be executed in real-time. Figure 3.8 shows how SURF algorithm can match two traffic signs even if one is slightly rotated. It also shows that it can differentiate signs which resemble each other.

Figure 3.8: SURF interest point detection

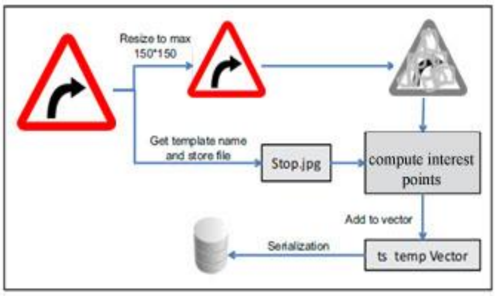

Figure 3.9: SURF database detection for traffic sign templates

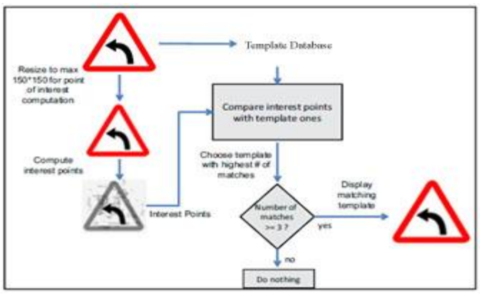

Figure 3.10: Recognition of traffic signs using interest point descriptor

We create a SURF database program for creating templates for each traffic sign. (See Figure 3.9). Each traffic sign is sized to be 150 * 150 pixels. Next, we develop the last stage of the algorithm which performs the matching operation with the detected boundary boxes and the SURF database as shown in Figure 3.10. Here, the interest points computed for the current boundary box are compared to each group of interest points contained in the vector to template. If the number of matches is not greater or equal to 3, we discard the boundary box (it was a false positive from detection stage). Average interest point's calculation time (for 150x150 pixels) was 0.25 sec using U-SURF algorithm.

IV. CONCLUSION

This paper presents a new method for real-time recognition of traffic signs. The proposed algorithm is based on YCbCr color space. Shape based filtering, use of discriminative features and SURF interest point descriptor. The algorithm has robust performance and it can detect signs even if they are viewed from an angle and the traffic sign template database can be easily updated. Reduced computational complexity of the algorithm enables a real-time operation with embedded systems, making it feasible for in-car applications.

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